A BRIEF SUMMARY OF FAME SCIENCE

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ABSTRACT
A poster-level review of FAME science is presented.

Key words: FAME — science applications

1. A BRIEF SUMMARY OF FAME SCIENCE

1.1.Distance Scale

FAME will be able to directly measure distances to approximately 30 Cepheid variable stars and 20 RR Lyrae variable stars, providing a refinement of the period-luminosity-color relation. Proper motion and parallax measurements of stars in the solar neighborhood will lead to more accurate determinations of the Oort A and B constants, providing refinements of both the galactic rotation curve and its derivative and the distance to the center of the Galaxy, upon which the extragalactic distance scale rests.

1.2.Galactic Structure

Several topics of Galactic structure will be addressed by FAME. Distances and proper motions of all spectral types within 2-3 kpc of the Sun will allow kinematic population studies that will assess the local escape speed, mass density, disk dark matter fraction, and the local rotation curve.

1.3.Star Clusters

FAME will be able to measure parallactic distances and proper motions of the 5 nearest globular clusters (1.9 to 3.4 kpc) at the 10-20 percent level. Old open clusters are important for Galactic disk evolution studies; 19 of these lie within 1.7 kpc and can be measured at the 5% level. Young clusters serve as tracers of spiral arms, Galactic rotation, and star formation; useful science can be done at the 50 μas/yr level.

1.4.Stellar Masses

Less than 5% of visual binaries (most of which are less than 20 pc distant) have good mass determinations. FAME, with its 2-3 orders of magnitude parallax measurement improvement, would greatly increase the number of reliable mass determinations. Accurate masses of massive stars would constrain high-mass stellar evolution models.

1.5.Stellar Luminosities

FAME would provide accurate distances to stars of all spectral types, hence improving the mass-luminosity-metallicity-age relationship. Additionally, we could finally obtain definitive absolute magnitude calibrations of early spectral type stars.

1.6.Exotic Objects

Black hole candidates within reach of FAME:

	m_v	D(kpc)	$M/M_\odot$	σ_D(%)
V616 Mon	11.3-20	1	>3-9	5
Nova Mus 1991	13.4-20	1.4	?	20
Cyg X-1	9	2.5	9	6
V404 Cyg	11.5-18	1-3	8-15?	5-15

The last column shows the distance error (as a percentage) that would result from FAME measurements. Determination of dynamical masses for these objects could provide conclusive evidence for the existence of black holes in these systems.

1.1.White Dwarf Stars

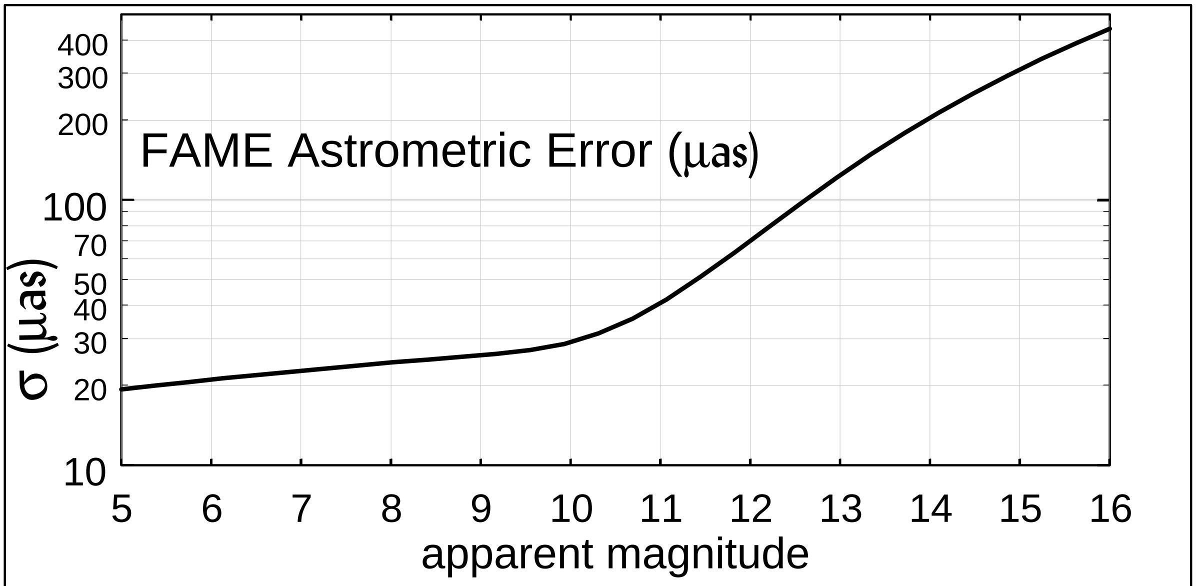
The white dwarf mass distribution has important implications for the progenitor population and Galactic evolution. Currently, distances to the 162 known WDs within 25 pc are poorly known, leading to a poorly calibrated mass-radius relation. FAME would drastically reduce the distance uncertainties to nearly all WDs within 25 pc and significantly improve the WD mass-radius relation.

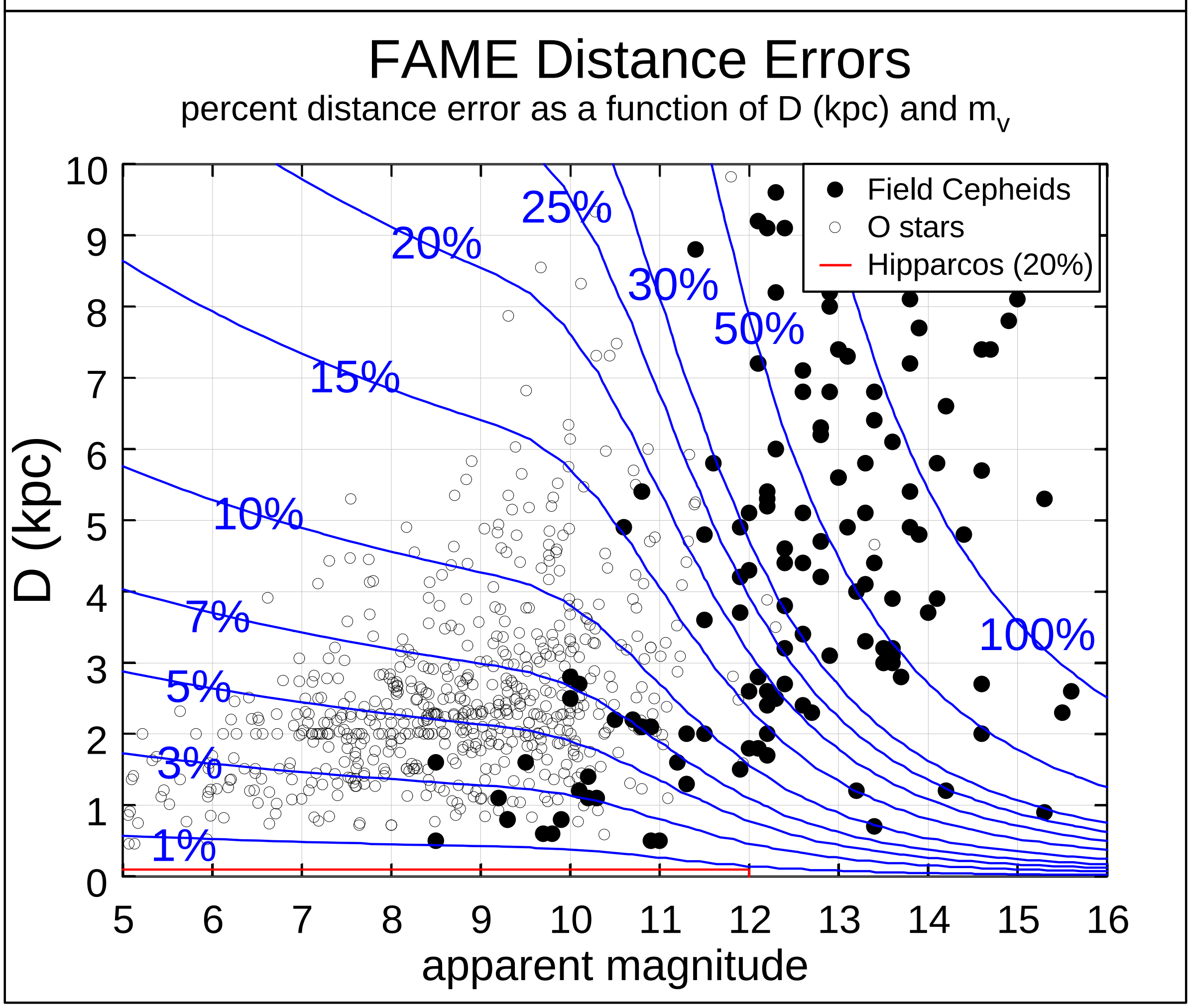
1.2.Global Reference Frame

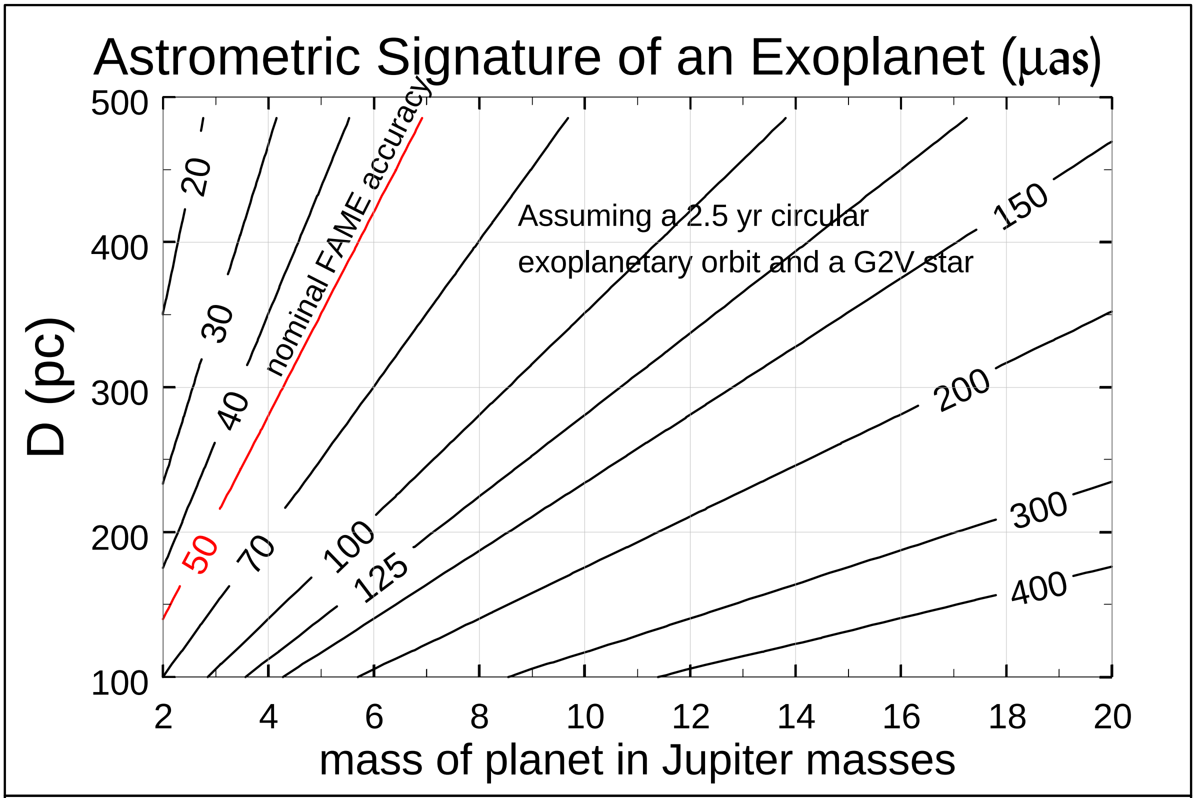
The definition of a very accurate global reference frame (GRF) is of considerable astrophysical importance. Currently, position errors in the FK5 catalog are ~10 mas at epoch 1940. Systematic errors are at the 0.1-0.2 *arc second* level. The current radio/optical frame disparity is roughly 10 mas. FAME would be capable of defining a bias-free GRF at the 50 μas level, tied to the radio frame.

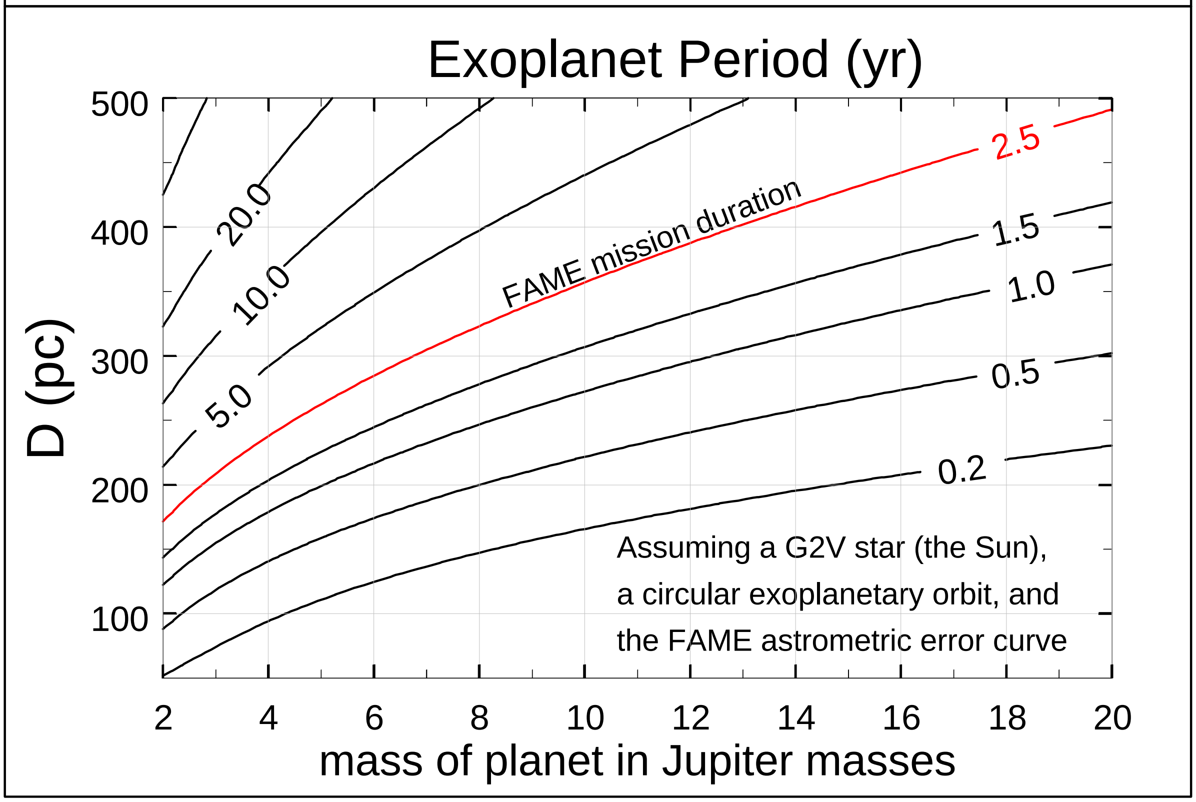
1.3.Extra-solar Planetary Systems

Future large space astrometric instruments capable of studying and characterizing exoplanets will likely be pointed missions. A precursor survey instrument like FAME would search for exoplanet candidates among a large sample of stars, serving as a valuable filter for the large missions. Evidence from ground observations already exists for several exoplanets, ranging in mass from 0.5 to 6.6 M_J. The astrometric signature of the Sun due to Jupiter, seen from a distance of 100 pc, is nearly 100 μas (peak to peak). With the nominal 2.5 yr mission, FAME could detect astrometric signatures of large, short-period exoplanets around nearby stars up to several hundred parsecs distant.


FAME Astrometric Error (µas)
σ (µas)
400
300
200
100
70
50
40
30
20
10
5
6
7
8
9
10
11
12
13
14
15
16
apparent magnitude


FAME Distance Errors
percent distance error as a function of D (kpc) and m_V
D (kpc)
10
9
8
7
6
5
4
3
2
1
0
1%
3%
5%
7%
10%
15%
20%
25%
30%
50%
100%
Field Cepheids
O stars
Hipparcos (20%)
5
6
7
8
9
10
11
12
13
14
15
16
apparent magnitude


Astrometric Signature of an Exoplanet (μas)
Assuming a 2.5 yr circular
exoplanetary orbit and a G2V star
nominal FAME accuracy
20
30
40
50
70
100
125
150
200
300
400
D (pc)
500
400
300
200
100
2
4
6
8
10
12
14
16
18
20
mass of planet in Jupiter masses


Exoplanet Period (yr)
FAME mission duration
Assuming a G2V star (the Sun),
a circular exoplanetary orbit, and
the FAME astrometric error curve
20.0
10.0
5.0
2.5
1.5
1.0
0.5
0.2
D (pc)
500
400
300
200
100
2
4
6
8
10
12
14
16
18
20
mass of planet in Jupiter masses